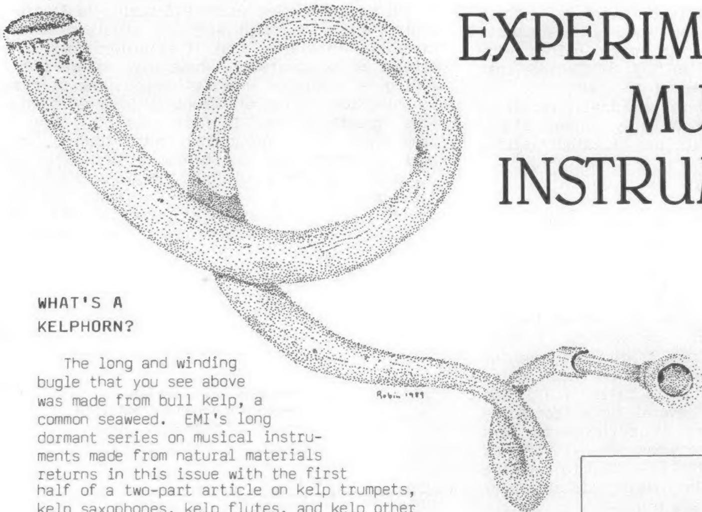
VOLUME V #6 APRIL 1990 PRICE $3.50

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS



Kelphorn drawing by Robin Goodfellow. See the article starting on page 6.

WHAT'S A KELPHORN?

The long and winding bugle that you see above was made from bull kelp, a common seaweed. EMI's long dormant series on musical instruments made from natural materials returns in this issue with the first half of a two-part article on kelp trumpets, kelp saxophones, kelp flutes, and kelp other things. Also in this issue we have a look at Dobros and National guitars, and their extraordinary sound radiating system. And there's more, you'll find when you open up -- but let's begin now with the Dobro story.

RESOPHONICS

Introduction by Bart Hopkin

One of the truly unique and inventive American musical innovations of the early 20th century was creation of resophonic instruments. "Resophonic" and the synonymous alternative "ampliphonic" --don't ask who coined the terms -- refer to a radically different string instrument sound resonating system first created by John Dopera and his brothers in the 1920s. It was subsequently used in guitars and other plucked strings made primarily by the National and Dobro companies. These instruments are easily recognized by the presence of a large circular metal plate, with holes cut out in decorative patterns, covering the better part of the face of the instrument. The rest of the body may be wood or metal. At a casual glance, it might be easy to assume that these specimens are simply guitars with metal soundboards in place of the traditional spruce. The innards of the instrument, however, reveal something quite different.

Beneath the cover plate one finds a piece of very thin aluminum, in a sort of a hubcap-like shape comprising a

(continued on page 12)

IN THIS ISSUE

LETTERS

REGARDING THE MYSTERY DRAWING reprinted on page 6 of the February EMI [showing a keyboard with mewing kittens for sounding elements]: I can't give you the origin of the drawing itself, but I may be able to identify the instrument.

It appears to be an early 19th century keyboard instrument which used an equally distempered catatonic scale system. It never gained wide acceptance, possibly due to high maintenance cost -- it was regularly in need of a tuna.

Speculation is that it was originally conceived as an attempt to appease early animal rights activists who protested the use of catgut* strung instruments.

Jeff Kassel

*Thanks for your clarification [on the use, or, actually, non-use, of catgut strings] in the same issue's "Musical Strings" article.

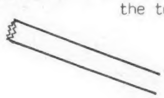
JUST A NOTE ABOUT YOUR STRINGS ARTICLES, which I enjoyed. You mention that you know of no instrument that uses human hair for strings. I don't either, but there is a strong tradition in song of a magical instrument, strung with human hair. This song cycle includes Child ballad #10 , "The Two Sisters," as well as several songs from Scandinavia, where the story is believed to have originated. In the song, a young woman is drowned by her jealous older sister in a dispute over the attentions of a suitor. The younger sister's body is recovered by a musician, who makes an instrument from various parts of her body. The instrument is generally a harp or fiddle. Here is a translation of part of a Swedish version of the song:

> The harper carried her to the shore
> And made of her a harp so rare
> The harper took her golden hair
> Harp strings he winds of it
> The harper took her small fingers
> And made the harp tuning pegs of them
> The harper took her snow-white breast
> The harp, let it sound with a sweet voice

The song continues that this musician is hired to play at the older sister's wedding (to the younger sister's fiance). In most Anglo and American versions, the harp, or, more usually, the fiddle, can only play one sad tune, and there the song ends. Often, the more supernatural aspects of the story are no longer part of the living tradition. In Scandinavian versions, however, the magical instrument sings of itself, confronting the older sister with her crime, in the presence of the wedding guests. The song usually ends with the older sister being burned at the stake. There's a lot of symbolism in the story, and whenever I see an anthropomorphic instrument, I think of this song.

Debbie Suran

I REALLY LIKE your tools & techniques section -- although it's sometimes top heavy on technical specs, but I guess there's a place for that too! As a contribution to that column let me suggest this tip (Tools, Techniques & Tips?) Periodically in EMI people suggest using PVC tubing in instruments, which you print with the required safety precaution disclaimer that it is proven toxic. In several of my creations I have used Nature's PVC tubing -- otherwise known as bamboo. The problem in using long pieces of bamboo is in removing the nodal growth plates. I offer this tip. Take a long piece of EMT (electrical metal tubing) conduit -- longer than the bamboo -- and file and grind the end like a hole saw. Be sure to take a vise grip and put a little alternate set on the teeth. EMT comes in different diameters to match the bamboo and is easy to work -- you can make this tool in about fifteen minutes.



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EXPERIMENTAL MUSICAL INSTRUMENTS
Newsletter for the Design, Construction and Enjoyment of New Sound Sources

ISSN 0883-0754

Editor
Bart Hopkin
Editorial Board
Prof. Donald Hall
Roger Hoffmann
Jonathan Glasier
Jon Scoville
Graphics contributor
Robin Goodfellow

Published in February, April, June, August, October and December by
Experimental Musical Instruments
P.O. Box 784
Nicasio, CA 94946
(415) 662-2182

Subscriptions $20/year ($27 outside the U.S., Mexico and Canada).
Back issues $3.50 apiece.
Cassette tapes $6 apiece.

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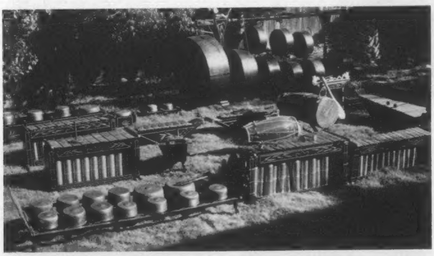
SUBMISSIONS: We welcome submissions of articles relating to new or unusual musical instruments. A query letter or phone call is suggested before sending articles. Include a return envelope with submissions.

hand on small pieces of bamboo and recently cored a 9' long, 3' diameter piece by chucking a large diameter EMT in a heavy duty lathe with tail stock removed. If you wish to finish it further, use a round drill rasp on one or several drill extensions. Another tip --you used to be able to get long nice pieces of bamboo cheap from rug stores. Your final piece will have a whole different feel than PVC.

The superball mallet is great and has been in use for some time -- it is indispensable in anyone's mallet collection -- but what is the best glue to attach it to the handle??

Bob Grawi & Pip Klein

OVER THE LAST TWO YEARS I have been building a set of Javanese gamelan instruments. The frames are modular in design, so that other tuning systems can be used. The keyboards and resonators lift off. The gongs and keys are steel, various gauges. The bonang, kenong, kethuk and kempyang [sets of small, gong-like chimes] are copper. Metal keys are painted gold to improve appearance and prevent rusting. Wooden keys are teak. Name of gong is **Kyahi Wisiking Wuluh,** which means "Venerable Sir Whispering Grass," in reference to bamboo. My tribute to a wonderful plant. Anyway, I've been a very busy boy! Gourds and bamboo continue to lurk approvingly in the garden. I hope to build some justly tuned instruments this year ...



Gamelan Kyahi Wisik Ing Wuluh, built by Matt Finstrom (except drums), 1989.

Another thing I wanted to tell you regarding the gamelan project -- I had an experience with bladders. I recently completed a rebab (bowed string instrument) which called for a bladder parchment as a sounding "board." I got a fresh bladder from a university meat lab. It came from a steer, which was as close as I could get to a water buffalo. Anyway, when I got the thing home, I didn't know what to **do** with it. It was thick and non-stretching until I discovered how to remove the muscle layers enveloping it. I finally got it cleaned off and it stretched thin and clear. When dry, it resembled wax paper in feel and weight, but was very strong. I wet it again briefly when I was ready to mount it on the instrument. When wet, it clung like plastic wrap to the wood and didn't require any holding or pulling to keep it in place. I used hide glue and small tacks to keep in in place after it dried, but I had the impression that I didn't need to. It seemed to stick all by itself. The tone is far superior to skin, which I have also tried for this purpose. Perhaps this info will be of use to your readers. It doesn't get any bladder than this. (Sorry, couldn't resist!)

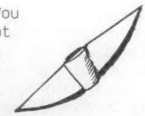
Matt Finstrom

THE BALLOON ARTICLE [EMI Vol. V #4, Dec. 1989] really hit home. I did not know anyone else fooled with 'em.

I might ought to explain the Joy Bottle. You just wash it out good, so you don't get soap in your mouth, fill it with water and squeeze almost as tight as you can while the water comes out -- then you're ready to play. You blow over the hole and squeezing raises and lowers the pitch by changing the size of the chamber. It works real good on several bottles.

The syringe is similar. I am a diabetic, so I have plenty.

The thimble is trickier. You control the pitch by the amount of lip over the thimble; the more lip, the lower the note.



A string on a stick with a styrofoam cup works good -- I call it a Bowjo.

Tony Blanton

EMI's POLICIES REGARDING LETTERS

EMI gets lots of mail, and we enjoy sharing some of it in each issue's letters column. We follow two main criteria in deciding what letters to print. First, we don't print letters which the writers did not intend for general consumption. (If it is unclear whether the writer would want his or her letter made public, we double check before running it.) Second, we run letters that will be of interest or concern to at least some of our readers. That usually means letters which have something to say about instruments of one sort or another, or letters which express an opinion that wants a hearing. We often print only selected portions of letters; this is mostly a matter of retaining appropriate material for publication while omitting requests for back issues and similar mundane business.

Receiving letters on the diverse topics EMI covers is always enjoyable on this end, and our feedback suggests that readers follow and enjoy the letters section too. Some of the most interesting information in EMI can often be found here on pages 2 through 5. So, please, keep writing; EMI and its readers need to hear what you have to say. Incidentally, in possibly ambiguous cases, it doesn't hurt to indicate it if you specifically do or don't want your words to appear in print.

CASSETTE REVIEWS IN EMI

We are planning to do a batch of short reviews of independently-produced cassette tapes in one of the coming issues. If you have produced a cassette featuring unusual instruments, send a copy along (EMI, Box 784, Nicasio, CA 94946) so we can include it. Be sure to enclose reasonably complete notes as to what instruments appear, and if the cassette is for sale, please indicate price and any other relevant information. These reviews will be informative rather than critical; we'll simply try to indicate what's on the tapes and where to get 'em. The purpose is to serve our readers by letting them know what sorts of instrumental sounds are available on tape within EMI's remarkably diverse and creative community.

A PECULIAR INSTITUTION

I'm still waiting for my ten million dollars. Ed promised.

When I got my Publishers Clearing House Sweepstakes package this year, I began to think about just who was doing what here, and why. Are these people handing out money out of pure generosity, I ask myself? "Of course not!" I answer. "They're doing it to sell magazines." This idea interests me, because I publish a magazine myself (you're holding it), and the idea of selling more holds a certain appeal. But selling magazines is not a wholly satisfying explanation for the existence of the sweepstakes, because most of the magazine subscription prices quoted in the Publishers Clearing House package are quite low; lower, in fact, than the publishers' fulfillment costs. Seemingly not a good way to make a profit. How can we make sense of this? "Follow the money trail," suggested Woodward and Bernstein. Let's try it.

Publishers Clearing House sends out sweepstakes entry forms, designed in such a way that respondents may be lured into sending magazine subscriptions along with their entry forms when they return them. The funds thus realized, one imagines, go in part to covering Publishers Clearing House costs of operations (including prize money), in part to return on investment for the sweepstakes promoters, and in part to the magazines subscribed to. The magazines' portion doesn't cover their costs; instead, the increased visibility and wider circulation allows them to sell advertising space to sellers of other products. The sellers of other products benefit when people respond to their ads by buying more of their products.

In other words, this expensive and contorted system has been created by an alliance of interests in order to get people to order magazines they wouldn't otherwise order, in hopes that they will see the ads in them, in hopes that they will respond by buying products they wouldn't otherwise buy. What we actually find at the end of the money trail is the dollar that someone, under unrelenting commercial bombardment, was induced to spend on a pack of Marlboros. Interestingly enough, it's possible to describe this entire system without once referring the quality or value of either the magazines or the products advertised.

Let's compare this now to what happens when you subscribe to **Experimental Musical Instruments.** When you subscribe to EMI, you agree to send a specified amount of money in order to receive a certain magazine, because you find its contents valuable in some way. EMI takes the money and uses it to cover the costs of producing the best magazine we can and sending it to you.

Much simpler.

BH

Cris Forster, whose string design article appears elsewhere in this issue, recently gave a performance along with Chrysalis Ensemble members Heidi Forster and Adrian Sly in San Francisco. Cris, operating through his Chrysalis Foundation, has over a period of years been composing and building the instruments for a major vocal and instrumental work, to be titled **Ellis Island/Angel Island: A Vision of the American Immigrants.** During that time the group has rarely performed.

The music is highly experimental: Cris has been developing both his own instruments and his own intonational systems essentially from scratch, and simultaneously evolving the compositional style to give them voice. In experimental work we don't expect to see the degree of refinement that characterizes a well-developed classical tradition; its absence is readily forgiven. Yet the selections from the work in progress presented at this concert exhibited an extraordinary degree of refinement, purposefulness, and clarity of intent. The composition, the instrumental timbres, the tunings and the performance seemed to come together with as clear a voice as the Beethoven Quartet that (not so strangely, after all) shared the program.

This music has been a long time coming, as people who have followed its progress well know. Even now there is precious little of it ready for performance. It would be easy to feel impatient with a composer who hasn't been giving us much to listen to, but I'll say this instead: this stuff matures slowly. I'll wait. When **Ellis Island/Angel Island** comes of age, I hope others will join me in giving it a good listen.

BH

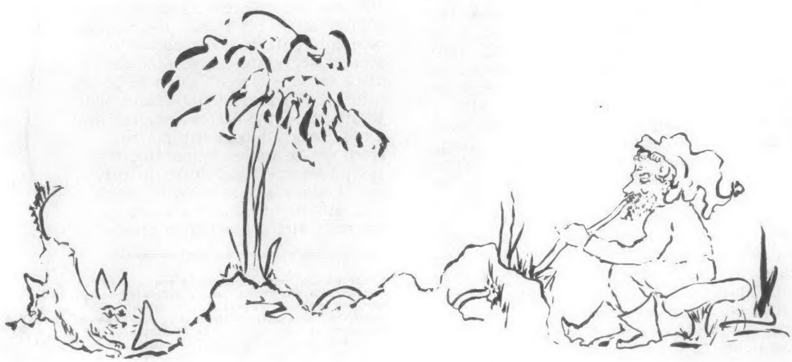
MORE ON MUSICAL STRINGS

Since the appearance of EMI's recent articles on the varieties of musical strings, a couple of fine articles on the subject have come out in other publications. One is the third installment of Mark Emery Bolles series of articles, "Real Strings," in the last issue of **Folk Harp Journal** (4718 Maychelle Dr., Anaheim, CA 92807-3040). It covers the topic of string scaling in user-friendly layman's math. The other is James Rickard's "String Making: Old and New," in the newest issue of **American Lutherie** (8222 South Park Ave., Tacoma, WA 98404). Rickard works in string design for the D'Addario company. Musical string making is a somewhat secretive business, but Rickard's article is full of nitty gritty on how things are done in a large scale state-of-the-art operation. Lots of clear and explicit photos appear.

TIME TO RENEW?

If the expiration date on your mailing label is highlighted in yellow, then this is the last issue of your subscription. Please renew now -- we need you! (And you need us!) If you don't have EMI's order form envelope on hand, just send $20 ($27 overseas), along with your name and address and a note indicating that this is a renewal, to EMI at PO Box 784, Nicasio, CA 94946.

Drawing by Robin Goodfellow



HORN FROM THE SEA: BULL KELP

PART 1

Another article in EMI's series on natural materials in instrument building

By Bart Hopkin

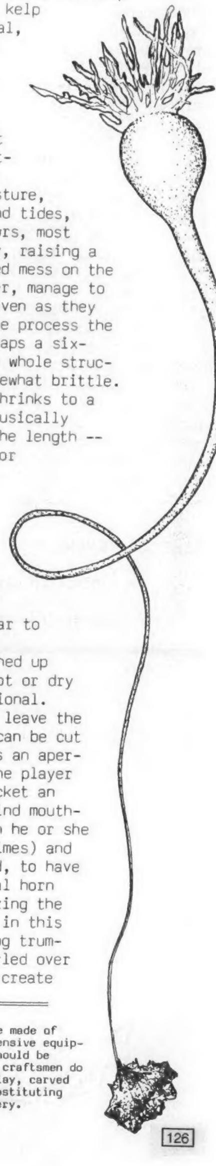
This article will appear in two parts. This first half introduces the reader to the seaweed known as bull kelp, discusses some general principles regarding its use in wind instruments of all sorts, and goes on to describe some of the possibilities for kelp trumpets. The second half, to appear in EMI's next issue, continues with descriptions of kelp flutes and kelp single and double reed instruments, and then provides practical information on working with kelp, drying it and finishing it.

Oboes and saxophones, cornets, tubas and sousaphones, all sound as they do in part because they use enclosed air columns of gradually expanding diameter. Conical or near-conical bores are a standard element in wind instruments the world over, for the reason that they possess highly desirable acoustic characteristics: they can make for well tuned, good sounding, and easily played instruments. The conical bore has the great disadvantages, though, that it doesn't often turn up in natural materials, nor is it generally available in commercially prefabricated materials, and it is difficult to manufacture at home.*

This article highlights a natural material possessing an excellent, well-formed conical bore. For people living in the right areas it's available in quantity without cost, and it can be prepared for use in musical instruments with only a modest amount of work. What is the material? Bull kelp.

Bull kelp, otherwise known as mereo cystis or macro cystis, is a seaweed found all along the U.S. Pacific coast. Anyone who has been to California's ocean beaches will probably know it, since it washes up in quantities too large to ignore. Fresh from the ocean, the full-sized plants take the form of incredibly long whip-like things. At the thick end is a bulb of three or four inches, sometimes more in diameter, with a mop of flimsy green weedy strands on top. From the bulb the plant extends downward in a long, flexible tail, narrowing from two or three inches just below the bulb to about a quarter inch at the far end, where, if it remains intact, it joins a clump of root-like material. An incision will reveal that the bulb is hollow, and likewise the long tail, which thus forms in effect a thick-walled tube of expanding diameter. There are dramatic displays of living bull kelp in the Monterey Bay Aquarium in Monterey, California, where huge vertical glass-walled tanks reveal great underwater forests of the stuff, growing upward from the ocean floor to heights of perhaps eighty feet.

Once washed up on the beach, the kelp begins to dry out. Fresh kelp looks and feels substantial, but vegetable fiber actually constitutes only a small part of the weight. The structure is filled out primarily with water. In drying, as a result, it shrinks to a small percentage of its original size. Given the quantity of moisture, the vagaries of climate and tides, and other disturbing factors, most pieces rot before they dry, raising a stink and leaving a tangled mess on the beach. A minority, however, manage to retain their basic shape even as they shrink drastically. In the process the thick walls reduce to perhaps a sixteenth of an inch, and the whole structure becomes rigid and somewhat brittle.



Most of the long tail shrinks to a diameter too small to be musically useful, but some part of the length -- occasionally up to 6 or 8 or more feet -- will constitute a well-formed tube, culminating at the bulb. If the top of the bulb is cut off at the right point, the remaining lower portion of the bulb becomes a natural flare at the end of the tube, similar to the bell of a trumpet.

Fresh kelp -- newly washed up and not yet beginning to rot or dry -- is also musically functional. The bulb can be cut off to leave the flared bell, and the tail can be cut off at a point which leaves an aperture of about 3/8 inch. The player need only pull from his pocket an appropriately-sized brasswind mouthpiece (a selection of which he or she naturally carries at all times) and insert it in the narrow end, to have a big, heavy, floppy natural horn which can be played by buzzing the lips, trumpet-style. Used in this way it makes a good swinging trumpet, with the bell end whirled over the head during playing to create

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* Most conical bore instruments are made of metal, requiring prohibitively expensive equipment and specialized skills. It should be noted that some skilled individual craftsmen do make conical bore instruments of clay, carved wood, and, more rarely, metals, substituting labor intensive methods for machinery.

impressive directional sound effects. Such a performance is quite striking visually, too. If by some chance the player has failed to bring a mouthpiece to the beach, the thick wall of the tubing around the aperture can be carved to form a mouthpiece-like shape that will support the lips during playing. It can also, with the help of one or more small incisions, be curled back on itself, again forming a comfortable lip-support shape. The taste and feel of wet seaweed is creepy, but true musicians are never squeamish.

Finding good kelp, either fresh or nicely sun-dried, is often very easy, but not dependably so. On some days it seems to be everywhere on the ocean beaches; at other times it is mysteriously absent except for useless rotted piles here and there. To determine why this is so (storms? high tides? seasonal fluctuations?) would take several trips to the beach at key times to observe the situation. This is something I have not gotten around to doing myself. Some beaches do seem to be better than others for finding good kelp, and human use of the shoreline is an important factor: kids love to play with the long snakes, and on beaches which host a continuous stream of visitors the kelp that washes up tends to get whipped and pulled and dragged all over the place. It usually suffers damage in the process. Any damage to the integrity of the plant prevents its drying well.

Procedures for drying kelp, and techniques for working it, will be discussed in the second half of this article, to appear in EMI's next issue. But first, let us look at what dried kelp can do musically.

MUSICAL POSSIBILITIES -- SOME PRELIMINARY NOTES

We begin by reviewing some generally applicable principles of kelpwinds, which will be helpful when we get to discussing specific types -- "brass," flutes and reed instruments -- later.

Bull kelp, as I have emphasized, provides us with a natural conical bore. But some specimens are more uniform in bore shape than others. A bore which widens at a uniform rate (before the point of abrupt widening at the bulb) should produce a harmonic overtone series well in tune. This means that the presence of the overtones sounding together as subtle components of tone quality in a single note will be harmonious and resonant, and also that the individual overtones sounded separately (as is possible on most wind instruments) will have agreeable and familiar pitch relationships to one another. A tube with slight irregularities, on the other hand, will produce something close to the harmonic series but slightly out of tune. Greater irregularities will lead to non-harmonic series. These unorthodox series may strike you as interesting and enjoyable, or may not.

Thus it is to be expected that tubes with more uniform bores will speak more easily, have a richer tone, and be less fidgety. But in practice I have found it impossible to predict which tubes will perform well. Often seemingly ideally shaped horns are disappointing, while apparent misfits sometimes come through beautifully. Wall thickness and rigidity, and irregularities thereof, may be a factor in all this.

Many kelp plants have a narrowing at the neck just below the bulb. This constriction throws off the overtone series and also creates problems with the rate of acoustic reflection back into the tube at the opening, so plants with this characteristic are best avoided. Alternatively, they can be cut off short of the point of narrowing. This means cutting off the entire bulb and some of the neck, and in doing so eliminating the bell. A bell-less horn may be less appealing visually, but from an acoustic point of view it's not necessarily unacceptable. After all, most modern woodwinds either have no bell or have a bell which plays a negligible role in tone quality on all but the lowest notes.

In cutting the bulb of a kelphorn to form the bell, there is a temptation to retain the beauty of the natural form by making the opening near to the top. This preserves more of the bulbous shape, leaving something reminiscent the bell of an English Horn. Be advised, though, that for most purposes, and especially for trumpets, you will achieve a better sounding result by cutting the bulb much shorter. The ideal spot to terminate the bell is just at the point where the outward curvature of the bulb ceases, and inward curvature has not yet begun. On kelphorns, this tends to make for a rather short, small bell. The open, outward curving bell helps allow higher frequencies in the timbral blend to make their way out into the open air rather than being reflected back into the horn, and thus makes for a more brilliant tone. The bulbous bell makes for a more veiled tone. Thus, it's not surprising that bulbous bells traditionally appear primarily on double reed instruments, which tend to have a piercing tone to begin with.

Dried bull kelp is lighter and less rigid than the metals, woods, glasses and plastics that are normally used to form wind instrument tubes. Does this affect the sound? Yes. You can verify this by firmly grasping different portions of a kelp horn as you play, and observing how your reinforcing the tube in this manner affects the tone. It's hard to say to what extent this makes the kelp instruments worse sounding or less playable. But it is a good idea, for practical reasons as well as musical ones, to seek thicker and stronger kelp pieces to make instruments from.

Let us look now at some of the possible kelp instrument types.

KELP TRUMPETS

Dried kelp makes for excellent natural trumpets (that is, lip-buzzed instruments without valves or side holes). Many people have made such instruments with good results. You can simply cut open the bell and cut off the long tail at the appropriate places, insert a brass instrument mouthpiece, and blow, bugle-style. You can try virtually any brass instrument mouthpiece, bearing in mind that a mouthpiece intended for a larger

instrument will naturally work better on a bigger piece of seaweed. Like a bugle, such instruments are restricted to the pitches of the lower portions of the harmonic series. Instruments up to twelve or fifteen inches in length will produce one or two clear notes (possibly more for a trained trumpeter). At perhaps eighteen inches three or four notes become possible, and with them most of the familiar bugle calls. Horns that are longer still will reach further into the overtone series, perhaps at the same time loosing the bottom note or two. If your horn is long and narrow, if you are using a small french horn mouthpiece, if you have a good brass lip, you will be able to produce tones well up into the series where the available pitches are closer together, and the repertoire will be considerably larger.

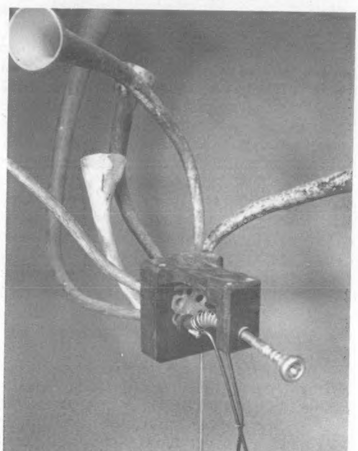
If you do use an inserted metal mouthpiece, it is a good idea to reinforce the kelp at the point of insertion by placing a metal band around the outside. This is easy to do using a half inch wide ring cut from metal tubing of the appropriate diameter.

You can also create a functional mouthpiece from the body of the horn itself **before drying,** by making two small or more slits at the mouthpiece end, curling it back on itself and allowing it to dry in that shape (drying in this case will be difficult though, for reasons explained later).

The tone quality of natural kelphorns varies considerably, but for a large percentage it is excellent: strong and clear and brilliant. This is the advantage of sticking with the natural horn and accepting a limited number of available pitches. Valves and fingerholes create irregularities in the air column, and these affect tone and playability. An unencumbered natural seaweed horn will often play more nicely than a commercial brass instrument with all the hardware.

Yet it is tempting to try to expand the natural kelphorn's range. I have tried a couple of approaches to this. My first was to make a many-belled instrument, played through a single mouthpiece leading to a system for valving between several horns of differing lengths. As the old song says, the music goes round and round, oh-oh-oh-oh, oh-oh, and it comes out here. ... Or else here ... Or over there ... depending on which horn you valve the sound through. (Historically there have been multiple-belled trombones and various other many-belled oddities, and one can still, though rarely, find a double-bell euphonium.) My six-belled kelphorn was one of the most interesting **looking** instruments ever made. The sad truth, though, is that without the benefit of a skilled machinist in a well-equipped shop, it is

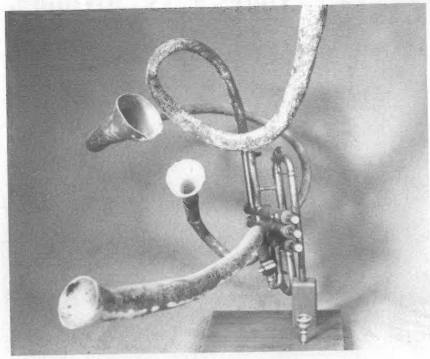
BELOW LEFT -- The many-belled kelp horn, a great looking but not-so-successful instrument made and played by the author. BELOW RIGHT -- Its valving system: A flexible tube with a soft rubber end gasket, manipulated by the metal handle, directs the air to one or another of the six holes and thus to one of the six horns.



LEFT: Kelp horns on a cornet body, played by the author with knee support from future kelphorn player Shane.

RIGHT: a closer look at the same instrument (in a wooden stand).

BELOW RIGHT AND OPPOSITE CENTER: kelp natural trumpets.



nigh impossible to make an air tight valve with the capacity for fluid switching that music making demands. My valving system was crude and clumsy. It worked sort of. But the very considerable loss in tone quality and the difficulty of manipulation discouraged me from playing the instrument seriously or spending time trying to refine that particular design.

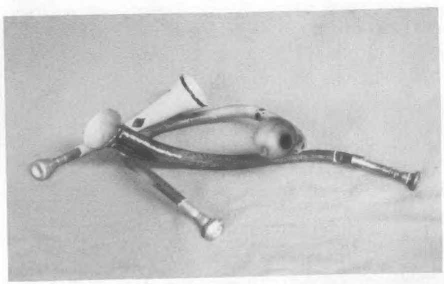
Instead I made another multiple-bell instrument, this time using the body and valves from an old cornet. At each point where an existing valve sent the wind through one of the loops, I short circuited the system by attaching a separate kelphorn of a different length. Four horns can be attached in this way. With the convenience of button valves made by people who actually knew what they were doing, this instrument is much easier to play than my earlier attempt. The sacrifice in tone quality as compared to a natural kelphorn, though, is still quite noticeable. I find myself again returning to my preference for the natural horns, in spite of their limitations.

As a compromise instrument, I have also made a tuned kelphorn set, consisting of three natural horns mounted together but with separate mouthpieces in a line.

Another means for increasing the number of pitches available on a trumpet is side holes -- that is, tone holes identical in function to those of familiar woodwind instruments. Many early lip-buzzed instruments were made this way, most notably the cornetts (by modern convention spelled with two Ts to distinguish them from the today's brass valved instrument) and their big brothers, the serpents (wooden side hole trumpets). The tone of such instruments tends to be less impressive than that of natural horns or valved instruments, because trumpets more than woodwinds seem to benefit greatly from the increased clarity and brilliance afforded by the the bell. (When playing instruments with open side holes, most of the sound exits through the holes rather than the bell).

I have made some functional side hole kelp trumpets. My most successful one had five tone holes covering a range of a fifth before jumping the octave to the next register. A skilled trumpeter could have some fun up above there in the region where my own lips give out. The all-holes-closed tones are, as would be expected, noticeably superior to the open-hole tones, which tend to be duller and less fixed in their resonant pitch. There are several other considerations that arise in connection with tone holes; for instance, to sound well, side hole trumpets seem to call for relatively large tone holes, which can be hard to cover completely. The wide spacing between holes demanded by larger instruments presents yet another challenge. This article is not the place to address these matters fully, but we will have a bit more on tone holes in seaweed in the second half.

OK, we'll stop here for now. Tune in next issue for kelp saxophones, oboes, and flutes, and notes on kelp drying, working and finishing.



PLAIN STRING CALCULATIONS

By Cris Forster

I would like to offer this article as a continuation of Bart Hopkin's articles on musical strings. Musicians or instrument builders interested in exploring alternate tunings or new instrument designs may find it relevant to know that the musical qualities of stretched strings are closely related to a set of four acoustic equations. These equations combined with tensile strength calculations can be helpful in providing an instrument with optimum tone and resonance, while at the same time ensuring that the strings and the instrument will last.

(Before I begin, I should point out that the following discussion is true for plain wire strings only. Wound strings need a slightly different and more complex approach).

There are four variables that must be considered while analyzing the behavior of plain strings: (F) frequency, (T) tension, (L) length, (D) diameter. If one knows any three of these variables, the **fourth** can be easily predicted. Solving then for any one of these four variables, the equations are:

$$F = \frac{1}{LD}\sqrt{\frac{GT}{\pi S}}$$

$$T = \frac{F^2 L^2 D^2 \pi S}{G}$$

$$L = \frac{1}{FD}\sqrt{\frac{GT}{\pi S}}$$

$$D = \frac{1}{FL}\sqrt{\frac{GT}{\pi S}}$$

The letters G, S, and Pi refer to constants which are explained below. Before all variables and constants can be combined to solve any of these equations, they must first be expressed in units of measure that are consistent with one another. With the exception of F and Pi, all measurements are given in inch/pound units:

F = Frequency, in cycles per second

T = Tension, in pounds of force

L = Effective vibrating string length, in inches

D = String diameter, in inches

G = The acceleration due to gravity on earth, is usually expressed as 32.2 ft/sec^2. Since all linear measurements are here expressed in inches, the value 32.2' * 12" becomes 386.4 inches/sec^2.

π = Pi, a constant, rounded off to 3.1416.

S = Weight per unit volume for a given stringing material, in pounds per cubic inch. The weights for four common materials are:

Material	Weight/Volume
Nylon	.038 lb/in^3
Steel	.283 lb/in^3
Brass (CDA 260)	.308 lb/in^3
Phosphor Bronze (CDA 510)	.320 lb/in^3

Suppose now that there is a new instrument on your bench which needs a string 21 inches long, tuned to 392 c.p.s. (G above middle C on the piano), using a steel music wire .022" in diameter. You have inspected this instrument and have decided that it can withstand about 100 lbs of tension. You are certain that 200 lbs of tension would destroy it. Or perhaps more realistically, this new instrument needs ten such strings and it can withstand about 1000 pounds; 2000 pounds would definitely require a new design with stronger materials. Solving then for (T) tension:

$$T = \frac{392^2 \text{ cps} * 21^2 \text{ in.} * .022^2 \text{ in.} * 3.1416 * .283 \text{ lb/in.}^3}{386.4 \text{ in./sec}^2}$$

$$T = \frac{153664 * 441 * .00048 * 3.1416 * .283}{386.4}$$

$$T = \frac{29160.4}{386.4}$$

$$T = 75.5 \text{ lbs.}$$

From this we conclude that the 0.022" steel music wire is well below the acceptable 100 lbs per string limit. If the answer for (T) had been over 100 lbs of tension, then it would have been necessary to repeat the calculation using a thinner diameter steel wire.

However, since we know now that this hypothetical instrument will support the tension of a 0.022" wire, the question still remains whether the string will give a clear tone and whether it will last.

On musical instruments, strings are generally tensioned between 50% and 70% of their **break strength.** If they fall too much below 50% they are generally too loose and will sound weak. If they are too much above 70% they are generally too tight and will break prematurely. However, how tight a string should be depends on two important questions: (1) what quality of tone, or timbre, is desired? (2) how should the string feel under the hands, picks, or bows?

To determine the general breaking point of a string an **average tensile strength** value for the given material is used. (In practice, tensile strength values will vary depending on the diameter of the material. Precise figures for specific diameters are available for steel music wire. For brass and bronze these numbers may be hard to find.) Tensile strength is defined as the force

in pounds required to pull apart a material having the cross section of one square inch. The tensile strengths for the three metals in the table below refer to materials that have been spring tempered, which are three times stronger than the same metals in a soft state. CDA numbers identify the alloy.

Material	Average Tensile Strength
Nylon	45,000 lbs/in^2
Steel	352,000 lbs/in^2
Brass (CDA 260)	130,000 lbs/in^2
Phosphor Bronze (CDA 510)	140,000 lbs/in^2

To find the 50% to 70% range requires two steps.

1. Find the cross sectional area of a specific diameter of wire, (find the area of a circle), and multiply it times the material's average tensile strength.

2. Compare this general break strength result with the actual tension of the wire on the instrument: determine the per cent ratio.

To find the area of a circle, use the formula $A = \pi r^2$. The radius is half the diameter, in this case .022"/2 = .011". Then

A = 3.1416 * .011^2 in.

A = 3.1416 * .000121

A = .00038"

Now multiply this area by the average tensile strength for steel.

Break strength = .00038" * 352,000 lb/in.^{2}

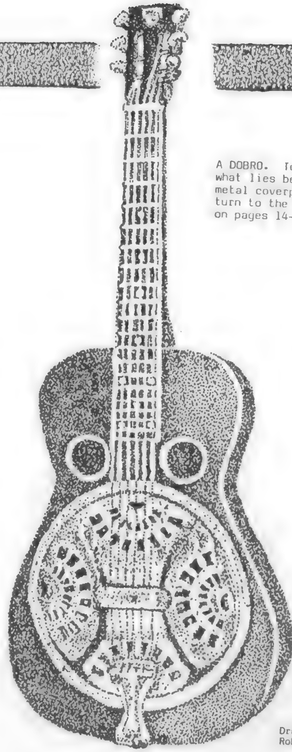
Break strength = 133.8 lbs.

Therefore, if the previously mentioned .022" steel wire is tensioned at 75.5 lbs it is at 56% of its 134 lb break strength; it is well within the range.

BELOW LEFT: Cris Forster shows how a set of weights was attached to a string to test the accuracy of calculations done on paper. Notice the black ball bearing over which the string makes a 90 degree turn down to the floor where the weights are attached. If the string cannot move with a frictionless support here, the frequency (the effect of the weights on the string's pitch) cannot be accurately measured.

BELOW RIGHT: A string winding machine built by Cris Forster in 1988. On this machine Cris can make long and thin wound strings not commercially available. All the major mechanical components of this machine ride on linear bearings to insure string diameter tolerances to within .0005".

INSTRUMENTS



A DOBRO. To see what lies below the metal coverplate, turn to the photos on pages 14-15.

Drawing by Robin Goodfellow

RESOPHONICS

Dobro & National, and their Singular Resonating System for Plucked Strings (There's Nothing Else Like It)

On following pages you will find an article on the history and construction of resophonic guitars. Bobby Wolfe, the article's author, is a resophonic guitar maker and repairman and proprietor of his own shop in Davidson, North Carolina, and a long time, diehard fan of the dobro sound. Special thanks go to the Guild of American Luthiers and its consistently fine publication **American Lutherie**, in which Bobby's article, as well as others on the subject, originally appeared.

Preceding Bobby's article is the short introduction to resophonics starting on page 1 and continued here; following it is a bibliography for those interested in pursuing the matter further.

INTRODUCTION, continued from page 1

shallow cone surrounded by a generous rim. The instrument's bridge actually passes through a slot cut out of the outer metal cover plate, and rests directly on this cone. The area around and under the cone is often separated from the rest of the instrument's soundbox by a circular wall of wood, similar to the frame of a tambourine, on which the rim of the cone may rest. Holes are cut in this baffle to allow communication between the inner and outer chambers. In the upper part of the face of the instrument there are additional soundholes (which may be covered by decorative screens), allowing the part of the soundbox outside the circular baffle to communicate with the outside air. This, it should be noted, is a description of a generalized basic form; in practice the shape of the baffle, the placement of soundholes, the form of the cone and even the number of cones are subject to endless variation.

OK, so what's going on here? Why did John Dopera wander so far afield from customary string instrument design?

A primary motive was volume. In those unelectrified days, he sought to create a plucked string instrument that would hold its own in ensemble with louder instruments. Mechanical loudspeaker technology was emerging at that time in connection with wind-up phonographs, and Dopera had done design work in that field. In his resonator design he devised a system for introducing plucked string vibrations into a light, rigid loudspeaker-like arrangement. Vibrations radiate from the front of the resonator cone and out through the holes in the cover plate, much as they would from the front of a loudspeaker.

And there is another special acoustic function that comes into play in the resonator cone system. Vibrations from the back of the cone are out of phase with those from the front (compressions in front correspond to rarefactions in back, and vice versa). The two would normally tend to cancel one another, especially in the lower frequencies. But the backside vibrations are isolated from the front vibrations by the face of the dobro and the cone itself. There's no sound hole in the immediate area. The backside vibrations are vented, however, through the relatively distant soundholes in the upper bout. This distance is effectively increased somewhat by the internal baffling. The delay associated with the distance the out-of-phase waves travel before being vented helps mitigate the front-vs.-back cancellation problem. For some frequencies (those for which the distance traveled is about half a wave length) it actually leads to reinforcement instead. This is the bass reflex principle, often employed in loudspeaker enclosure design. Its application in dobros is far from the theoretical ideal, but it does seem to have a positive effect in the instrument's projection. Also, by reinforcing selected frequencies, it helps create a characteristic resophonic sound.

And while the results vary quite a bit from one instrument to the next, there can be no doubt that Dopera succeeded in creating a louder instrument.

Many resonator guitars, as well as banjos, mandolins and such, are amazingly powerful. At the same time, he happened to create something with a distinct tone quality of its own. That tone, within limits, can be further adjusted by careful manipulation of the resophonic components. And all of this remains subject to continued experimentation and exploration, for as mentioned earlier, the variations on the basic form already are many, and so are the corresponding variations in tone quality and volume.

After developing his resonator system, John Dopera went into business making resophonic instruments with his brothers and a changing cast of associates and backers. Their first company was National, producers of the famous National Steel Guitar. The Doperas later broke with National and formed the Dobro company, making the instrument that has come to be known by that name. Both companies continued to make resophonic instruments, as well as reaching licensing agreements with yet other companies. Over the years new lines were continually introduced and new designs explored. As a result of this Byzantine commercial history, keeping track of the diversity of resophonic instruments made in those early decades has become a challenging hobby for present day enthusiasts.

In more recent years the instruments have remained in production, with the Dopera Brothers themselves in and out of the commercial picture at different times. Rights to the Dobro name are now held by the Original Musical Instruments Company (18108 Redondo Circle, Huntington Beach, CA 92648), under the ownership of Chester and Mary Lizak. OMI continues to manufacture Dobro guitars and mandolins, as well as supplying resophonic parts for both the old Dobros and Nationals.

Shortly after their appearance in 1928, resophonic guitars unexpectedly became a favored instrument among slide guitar players in the Hawaiian style. As a lasting legacy, resophonic guitars designed specifically for playing with a sliding steel bar in a lap top position (or the standing equivalent, with a strap) are widespread. Dobros built for this purpose have their strings set higher above the fingerboard. This configuration creates greater inward stress, so the neck on these instruments is a heavier rectangular shape. Other resophonic guitars (those not specifically designed for slide playing) tend to be shaped much like standard guitars.

The bodies of resophonic guitars may be wood or metal. (Metal-bodied instruments are usually associated with the old National company, and wooden with Dobro, but in fact both wood and metal instruments have appeared under both names.) The metal instruments were originally made of German silver (a brass alloy), nickel plated. Later other brasses and eventually steel were used. The wooden instruments are generally made of 3-ply hardwood. Recently some thinner spruce top instruments have been made, but heavier wood is usually considered more effective: rigidity and mass to support and provide counterpoise to the cone seem to be more important than the light, springy quality that one looks for in ordinary guitar soundboards.

It is worth adding here that these instruments, especially some of the highly decorated all metal models, are often extraordinarily beautiful in appearance: instruments that seemed thrillingly modern when they first appeared now survive as specimens of classic grace and dignity.

With this image in mind, we turn now to Bobby Wolfe's article, to explore these instruments in a little more depth.

THE BLUEGRASS DOBRO
America's 2nd Native Instrument

By Bobby Wolfe

This article appeared originally in **American Lutherie** Number 5, Spring 1986 (8222 South Park Avenue, Tacoma, WA 98408; membership & subscription $30/yr). It is reprinted here by permission. Some alterations have been made in the article for this printing; in particular, the original article contained more specific detail on the subject of dobro repair.

There is a little ditty known as "The Duck Principle." It says: If it looks like a duck, if it walks like a duck, if it quacks like a duck, then it must be a duck. Well, the Dobro only looks like a guitar, and even in this respect with significant differences. It doesn't qualify in the other ways, and I say it's not a duck.

Seriously, in my opinion, the mechanically amplified instrument known as the Dobro does qualify as the Number 2 Native American instrument.

This article is designed to acquaint you with the Dobro and to provide information on common repair and set up needs of the instrument. Today, in addition to those operating under the Dobro trademark and building the original instrument, there are many individuals building their versions. Most of these people have their own ideas and opinions about what works best. Therefore, I am not presenting my ideas, experiences, and working practices as the "last word".

First, let's define Dobro. **Dobro** is a registered brand name that is now also used generically to describe most resonator type guitars. The name comes from the Dopera (Dopyera) brothers. There are five Dopera brothers. There are five letters in Dobro. The word dobro means "good" in their native slavic language. Take your pick!

Brother John Dopera is most often credited as having done most of the development work on various instruments. John developed or invented the tri-cone National (a guitar with three smaller resonator cones mounted in a metal sheet under the cover plate) often seen with early native Hawaiian bands. He also developed the single cone National. All this was in the early to mid 20's. Most, if not all the brothers were part (owners?) of The National Company. In the late 20s, John developed the Dobro style resonator. They left (sold?) The National Company and set up the Dobro Company at this time. The Dobro design utilized

entirely different resonating parts. These parts, under the cover plate and inside the body of the instrument, form the only major dividing line that can be drawn between what sounds like a Dobro and what does not. Let's try to establish that difference now.

The National style cone is a simple dome shape with the bridge mounted on the peak of the dome. This style is known as the "biscuit bridge" because of the round bridge base. Sound produced by this cone is more metallic, more punchy, and it has more of a "boing" sound than the Dobro sound.

The Dobro style cone (see photo) has a differently shaped cone utilizing an eight leg "spider" bridge. The Dobro cone has a cross section shaped like a "w". That is, from its outer perimeter, it goes down then comes back up to a dome in the center, with the center dome being lower than the perimeter. The spider bridge sits on a ledge near the outer edge and is attached to the center dome of the cone with a tension adjusting screw. This assembly produces a softer, less metallic sound with more sustain than the National style cone.

BLUEGRASS-STYLE DOBRO

How did we arrive at today's level of interest in the "Bluegrass" Dobro?

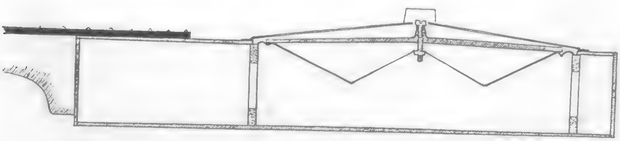
As mentioned earlier, the first major interest in resonator guitars was for mechanical amplification of sound. Then came the Hawaiian music craze of the 30s. At the very time of the introduction of the Dobro in the late 20s, Jimmie Rodgers, the "Grandfather" of country music, was in his prime, and sometimes used the Dobro in his music. Cliff Carlisle was one of the first steel bar pickers of the Dobro in country music. Then in the late 30s, Cousin Jody (Clell Sumney) and Brother Oswald (Pete Kirby), came along as Dobro pickers, along with Uncle Josh and Buck Barnes. Kirby, who is still with Roy Acuff today, kept the Dobro alive in country music until the early 50s. He is still performing today as the "King of Dobro".

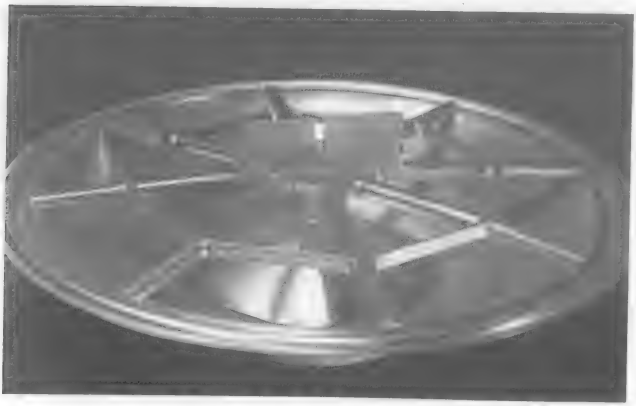
Other and better known Dobro pickers have now developed a new style picking in the Bluegrass mold. Two of the better known are Mike Auldridge and Jerry Douglas. Among these major pickers, the preferences in Dobro sound and looks are very similar. These are the pickers who, individually and without too much influence on each other, established the Dobro standards of today.

SOME QUICK FACTS

Because there are so many variations in Dobros, Nationals, and others, and for holding down the verbiage, I give you the following additional information:

* The Dobro Company, now OMI (Original Musical Instruments), has made and still makes both Dobro and National cones.
* The Dobro style cone instrument is used for both square neck (sliding steel bar) and Spanish (fret-





LEFT ABOVE: Cross sectional view of the components of the resonator system in a Dobro. Uppermost over the resonator area is the metal cover plate, including an additional small protective metal piece immediately over the bridge. Below that is the spider bridge, with a screw passing through the center and connecting to the cone (not shown are two small upright pieces of maple normally seated on either side of the screw in the slot at the center of the spider bridge, on which the strings actually ride). Below that can be seen the cone itself, with its W profile, and the edges of the soundwell on which it rests.

LEFT BELOW: A spun resonator cone with spider bridge, including the two maple pieces.

FACING PAGE LEFT: Dobro with the coverplate and cone removed, showing the soundwell and the wooden rod that runs from the soundwell to the neck.

FACING PAGE RIGHT: Dobro with the coverplate removed, revealing the cone, spider bridge and strings in place.

ted) styles of picking.
* Blues and rock pickers usually prefer the sound of the National style cone.
* The preferred Dobro for Bluegrass is the wood body, 12 fret square neck, with sound well and screened holes in the body.
* A large percentage of country records produced in Nashville feature the Dobro as both lead and backup instrument. It may be played Spanish or slide style on these records.
* The first 300 or so Dobros contained cones spun to shape.
* Dobro today makes both spun and stamped cones.
* A variation of the early cones used a shorter spider bridge that mounted on lugs stamped onto the sides of the cone.
* Dobro model numbers of the 30s and their prices were one and the same. The Model 27 was $27.00, the 45 was $45.00 and so on.
* Dobros were built with both "F hole" bodies and "screen hole" bodies.
* There are Dobros with and without sound wells.
* Some Dobros have thicker bodies. These were (usually?) by other manufacturers.
* Tut Taylor developed the first 12 string Dobro in the 60s. They have been commercially made since.
* The Mosrite Company built 14 fret Dobros in the 60s that used Formica in wood grains and in bright solid colors.
* While Mosrite owned the Dobro name, the Doperas continued to build their instrument under the names of "Hound Dog" and "Replica".
* During the "Hound Dog" and "Replica" years (after the war, when the Doperas did not own the Dobro trademark), the Doperas experimented with and built Dreadnought shaped bodies, fiberglass cover plates, etc.

CONSTRUCTION

John Dopera and his brothers were undoubtedly exceptional people in their field. They not only developed the Dobro, but they also adapted their mechanisms to mandolins, fiddles, banjos, ukes, and who knows what else. However, the mandolins and banjos are about the only other resophonic survivors.

The Dopera brothers were on the leading edge of electrically amplified instruments and actually produced some. They were certainly responsible for mass produced mechanically amplified instruments. However, the convenient utilization of the standard guitar body, the placement of the parts in the shape of a lyre, and other things, lead me to believe that they knew very little (by today's standards) about the mechanics or physics of what they developed. I think they worked mostly through trial and error experimentation, with John having most of the ideas. Speaker cones were certainly not old hat in the mid 20s, and yet this is basically what their cones are. Also, I ask you, how much was known about the "Bass Reflex Principle" as applied to speaker cabinets? This

principle is at work in the Dobro body.

The better sounding old Dobros have a "sound well" (see photo on page 15) that the cone sits on. The sound well provides baffling and back loading to the cone. The screened holes are in-phase outlets for the 180 out-of-phase sound waves off the back of the cone. I understand that someone has even experimented, with good results, with tubes in the holes similar to today's speaker cabinets. I must try that! Removing the screens usually increases volume.

The soundwell also provides structural support to the front panel of the instrument. To understand the need for this, consider the size of the hole in this panel and visualize the pull of the tail piece with the strings at full tension. There are two common side hole arrangements in the soundwell: round holes about 1 1/2" to 1 3/4" appear most often, and diamond shaped holes are less common. Dobro used no other hole pattern to my knowledge. I have a Regal with only three holes instead of the usual nine or ten. Without the soundwell or other baffling, the sound produced is usually weak and stringy.

Most builders (including me) have abandoned the soundwell in favor of a solid wood baffle/divider fitted across the narrow part of the body, sometimes called a skirt baffle. This effectively divides the body into two sections, as did the soundwell. Small openings at each end of the divider take the place of the holes in the soundwell and allow passage and phasing. This method, utilizing a much larger back side chamber for the cone, usually produces more volume and a brighter, more cutting sound while retaining the Dobro sound.

Without the soundwell for the cone to sit on, a separate ring of wood is glued to the underside of the front panel to form a ledge for this purpose. Also, without the support of the soundwell, additional bracing is required to keep the tail piece from pulling the end of the box inward. Most all Dobros will pull inward to a degree. While old and new Dobros are made of plywood which holds up well to the strain, many of today's builders prefer solid wood with bracing.

Another major structural difference between Dobros and regular guitars is in the neck. There's nothing apparent on the outside, but both Spanish and square neck Dobros, old and new, have an extended rod that fits through a hole in the neck block and fastens in the body. This rod is rectangular and is glued into a slot cut into the heel of the neck (see photo). The rod extends into the soundwell portion, under the cone, where it is fastened with one screw to a block of wood mounted to the back panel. Wood screws located under pearl position markers fasten the fingerboard to the body. All this makes up a three point support system for the neck that performs quite well.

SOUND

Just as there are many opinions about the various models and structural characteristics of the instrument, there are many different opinions about its sound and what it should be. The question of why some have good tone and low volume and some have both good tone and good volume seems to contribute to the mysteries of the Dobro. It appears that the more mellow sounding old Dobros don't have much body vibration. Those that have good volume appear to vibrate more.

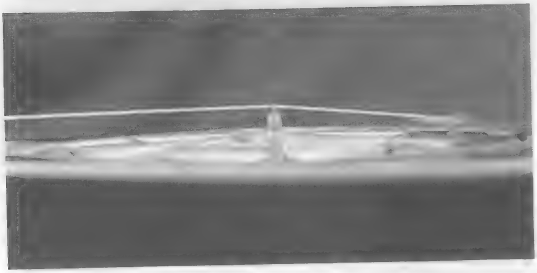
John Dopera is quoted as saying that the length of the neck rod and its placement affects the sound of the instrument considerably. He is also quoted as saying that spruce top instruments have less volume because of the thinner tops. Ed Dopera, in an article on the original Dobro prototype, states that three ply hard woods were used because the bodies had to be strong enough to hold the cone sound and not vibrate and kill the tone. Strange?

I have found that the slightly thicker bodies usually have better volume. Also, the newer skirt type baffles along with the thicker body, solid wood instruments give more volume. Typically, they cut better and can be heard in the usual five piece band. I have yet to hear a loud, good sounding Dobro that didn't vibrate all over when picked. It seems to me that the Dobro style cone and bridge are responsible for maintaining the Dobro sound/tone, while different woods, dimensions, baffling, and the like, are responsible for the increased volume and cut. It is my opinion that the better sounding instruments have complimenting resonant frequencies of the various components just like in a bass reflex speaker cabinet. I realize that a speaker cabinet shouldn't vibrate, but the speaker cabinet panels are not sound producers, whereas the Dobro body does contribute to the sound. The amount of passage from one section of the body to the other (amount of baffling) makes a difference in the sound. There is an element of "tuning" the box by varying these openings. On some instruments, the amount of change in volume and type of sound due to these factors can be dramatic.

SETTING UP THE DOBRO

In this section we will talk about establishing the optimal relationships between the vibrating elements of the dobro. The interaction between strings, bridge, cone, baffles and body are terribly important. They can be adjusted in many ways, and seemingly small adjustments make a big difference in the resulting sound. In the earlier version of this article appearing in **American Lutherie** I went into considerable detail concerning this fine tuning process, as well as on how to handle the kinds of repair problems that tend to arise. Here, however, I will bypass some of the particulars, and instead provide an overview of the most important relationships.

One of the central factors determining tone quality in a dobro is how the vibrations from the strings are transmitted through the spider bridge to the resonator cone. If the pressure between the bridge and cone is too light, contact will be poor and there will be poor transmission. If the pressure is excessive, the cone may collapse, or at least have it's life shortened as it gradually gives way. Since the cone is really quite thin



LEFT ABOVE: The wooden rod that runs from the neck to the soundwell, shown at the point where it joins the neck. In the photograph of the open soundwell on page 15 you can see how the rod terminates at the other end by joining the back with a single screw.
LEFT BELOW: A sideview showing the angle of fall from the bridge to the tailpiece, on a dobro with cover plate removed.

and fragile, it takes very takes very little pressure to do damage.

To ensure that all the parts fit together snugly, the dobro's cone and spider bridge must be well fitted and seated in the instrument. If gaps exist between the rim of the cone and its ledge, or between any of the feet of the spider bridge and the rim of the cone, buzzes will appear and resonance will suffer. Inserting shims or filling with glue at points where contact is lost may reduce buzzing but will reduce resonance as well. Trying to bring separated parts into contact by increasing downward pressure on the bridge or cone will damage the cone before it solves the problem. Corrections must be made by hand, by cleaning and leveling the ledge on which the cone sits, and if necessary sanding or filing one or more of the spider legs, to get a good fit all around. To hold the cone and bridge in place, the Dobro company has at different times used both nails and glue. With good fitting, neither are necessary; the parts can just rest in place under the pressure of the strings.

One of the factors affecting the pressure between bridge and cone is the the adjustment of the bridge tension screw. This screw passes through the bridge from above (fitting between two small inserts of maple on which the strings actually rest), and screws into a crimp in the center of the cone. To adjust it, first set the screw head just snug against the bridge. The adjustment range from that point is from ½ to 1½ turns. ½ to 3/4 turn should pull the parts together and remove any buzz or rattle and give decent tone. Some change of tone, volume and sustain will be accomplished within the 1½ turn range. Do not exceed that range: many a good $39 cone has been destroyed by someone looking for a better sound or trying to eliminate rattle and buzz. Tightening this screw will not correct an improperly seated cone and bridge.

The other factor affecting contact between bridge and cone is the pressure of the strings on the bridge. The strings naturally press down on the bridge as they pass over it between the nut and the tailpiece. The degree of pressure is affected by string gauge and tension. It also depends on the angle at which the strings slant down to the tailpiece after crossing the bridge. The angle can vary depending on the sound you want, but for a typical dobro set up, just about 1/8 inch of fall between the bridge and the tailpiece is a good norm to shoot for. To decrease the fall angle, you can raise the tailpiece using leather or similar material between the tailpiece and coverplate. It is also important that the overall distance between the bridge and the tailpiece not be significantly less than the normal distance of about three inches. This distance is necessary for string vibration to operate the cone. Visualize a tailpiece about one inch away from the bridge and imagine the sound it would produce! (I must experiment more with this.)

The effect of the tailpiece and string angle adjustment is somewhat like a radical change in string gauge and/or tension screw adjustment. Too much angle and too much down pressure on the bridge is similar to extremely heavy strings producing a harder sound with less sustain. The excessive bridge pressure will also cause the cone to sink or drop faster than it normally will. You will find that changing this string angle will produce dramatic changes in the sound of the instrument.

The string, nut, bridge, and tailpiece set up and adjustments, along with tension adjustments, should allow you to perform minor miracles of Dobro sound improvements. As on any other instrument, reasonable care and attention to detail will yield the best results. Just because this thing is made of plywood and has a chrome hub cap in the front of it, don't look down your nose at it and dismiss it as an unworthy musical instrument. Granted, it doesn't have the kind of wood, dimensions, bracing, and other detailed requirements that many instruments do, but it is every bit as demanding and finicky as any other instrument. Just look at all the adjustments that can be made!

(Over for bibliography)

FURTHER SOURCES OF INFORMATION ON RESOPHONICS

Wolfe, Bobby, "The Bluegrass Dobro", in **American Lutherie** #5, Spring 1986 (Guild of American Luthiers, 8222 S Park Ave, Tacoma, WA 98408). This is the original version of the article reprinted here. The original contained specialized information on Dobro set-up and repair that was not included in the current edition.

Brozman, Bob, "Slidin' Steel", in **Frets** (GPI, 20085 Stevens Creek Blvd., Cupertino, CA 95014). An excellent report on the history of resophonic instruments, with special attention to the physical make up of the instruments themselves, and lots of photographs.

Vande Voorde, Ed, "Gene Rhinehart's resophonic Guitar Cones", in **American Lutherie** (address above). An interview with an individual maker who has made and experimented with a huge variety of cone types and shapes.

DeNeve, R.L., "Resonator Guitar Construction," GAL Data Sheet #40 (Guild of American Luthiers address above). A three page report on the basics.

Brooks, M. "The Story of the Dobro by Ed Dopera", in **The Guitar Player Book** (New York and Saratoga, CA, 1987).

SOFTWARE

JI CALC 3.11

Software for synthesizer tuning and just intonation calculation, for Macintosh computers, from Robert Rich/Soundscape Productions. [Note: since this review was written, an upgraded version, JI Calc 3.2 , has become available.]

MICROTONAL MIDI TERMINAL 1.107

Software for MIDI instrument tuning and just intonation calculation, for IBM personal computers, from Denny Genovese/Denny's Sound and Light.

Many of EMI's readers have a special interest in tuning systems beyond the twelve tone equal temperament that is built into most commercially produced instruments. To some extent it is possible to explore unconventional tuning systems by ear and instinct alone, but most people who become interested in the subject sooner or later find it valuable to augment the naked ear with some mathematics.[1] Much of the math involved in the creation and analysis of tuning systems is not highly sophisticated. In fact, for just intonation scales, which are based in simple ratios, the math is mostly arithmetic. But even arithmetic becomes confusing and tiresome when operations and calculations become numerous and involved.

And so we come to the software reviewed here. Robert Rich's **JI Calc** and Denny Genovese's **Microtonal MIDI Terminal** allow you to create, analyze and manipulate scales at the computer by the inputting sets of ratios (representing relative rates of vibration, and corresponding to the pitches of the scale). The programs can perform a number of calculations with the data, and present the resulting information in various useful forms. More importantly for those who have the necessary hardware, both pieces of software can be used to retune synthesizers, allowing them to play in new scales created by the user.

There are two important differences between these two programs:

1) MMT is written for IBM PC and compatibles, while JI Calc is for Macintosh.

2) The two programs tackle the re-tuning of synthesizers in different ways. MMT uses the pitch-bend feature available on most synthesizers. JI Calc uses an internal tuning program that is built into certain synthesizers only. This means that MMT should work on any MIDI-controllable synthesizer with the right interface and a pitch bend feature, while JI Calc is set up for specific popular makes (listed in the review below). There are advantages and disadvantages to each approach.

Both programs require that the synthesizers be MIDI controllable, and that the necessary MIDI interfaces be in place on instruments and

1. For the purpose of mathematical analysis of pitch relationships within a scale, pitches are represented as vibration frequencies. These numbers, or the ratios between them, are the raw material of scale building from a mathematical point of view.

computer.[2]

For those without synthesizers, the programs remain valuable as intonation calculators alone. Some limited audio capacities are available through the computers' internal speakers as well.

Read on for individual reviews of the two programs.

JI CALC 3.11

Reviewed by John Chalmers

For anyone owning a Macintosh computer and interested in non-traditional tuning systems, JI Calc 3.1 is simply indispensable. The program can upload full-keyboard tunings to MIDI synthesizers of the Yamaha DX7 II and TX81Z families in less then 20 seconds and can use the Macintosh internal sound chip as well. The synthesizers currently supported include the DX7 IIS, the DX7 IID, the DX7 II FD, the DX7 IIEI, the TX802, the TX81Z and the DX11. [The original DX7, which lacked the programmable tuning feature of the later versions listed above, will also work if the E! modification is added.] Even if one does not have one of these synthesizers, the program is still valuable for studying experimental intonation. The Macintosh local sound is quite adequate for experimental purposes.

JI Calc 3.11 is a Hypercard stack[3] composed both of text files for on-screen help, including a brief article by Robert Rich describing what just intonation is all about, and a library of tunings. The bulk of the stack consists of "cards" bearing user-defined scales and a set of "buttons" (on screen commands) by which the display mode may be adjusted, the key changed, and some simple functions computed. The menu bar has the standard Hypercard functions, and a new MIDI window for uploading tunings to certain of the Yamaha synthesizers. Provision is also made for the new proposed MIDI Tuning Dump specification whenever it is adopted.

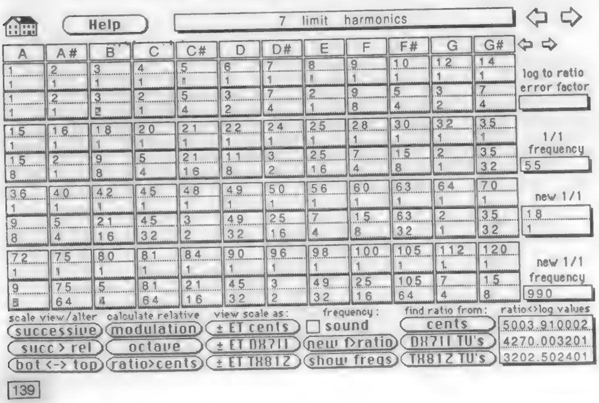
The card layout may be seen in the accompanying diagram. While the number of buttons at the bottom of the tuning field may appear daunting at first, one of the great strengths of JI Calc is its flexibility coupled to thorough and clearly written documentation. I have been unable to discover any serious omission or undescribed feature in the documentation. One can never go wrong with this program by following the directions.

Rather than paraphrase the already excellent documentation, I will explain the process of entering a new tuning and describe some of the features which may not be obvious from the card layout. Although the stack comes with a number of just intonation tunings such as Harry Partch's 43 tone scale, several 12-tone ratio sets, and portions of the harmonic series, entering new scales is very easy. Scales must be entered in ratios, but these may be either successive intervals or ratios from 1/1. Scales need not fill consecutive fields nor be limited to one octave. If the scale is only defined in cents or synthesizer tuning units, a special feature of JI Calc may be used to find a close ratio approximation for each note which may then be entered into the ratio fields. This procedure is rather useful, though it is somewhat slow and cumbersome. After the ratios are entered, the display may be put in the most desirable mode by clicking on the appropriate buttons. A keynote may be chosen, if A-440 is not desired, and one is then ready to hear the scale or send it to the synthesizer.

A much appreciated bonus feature of JI Calc is its ability to be used for equal temperaments, stretched octave scales, or essentially arbitrary sets of pitches. While one card can only hold 48 notes, multiple cards may be used to individually tune every note of the synthesizer.

For tuning equal temperaments, the procedure is extremely simple, requiring only that the user provide a ratio approximation to the first degree of the temperament. The equal division need not be of the octave; scales such as Pierce's 13th root of 3 or the 7th root of 3/2 are easily implemented with this program. Ratios are limited to fractions with both terms less than 10,000 (four digits), but this is not a problem as the accuracy of the tunings far exceeds the resolution of the synthesizer, or for that matter, the discrimination of the human ear.

Some of the other functions provided by JI Calc are pitches in frequencies (HZ), relative and successive cents, deviations from 12-tone equal temperament, successive and relative ratios, modulations to arbitrary pitches (which need not be in the scale)



AT LEFT: A screen from JI Calc, showing the basic card layout.

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2. MIDI, or Musical Instrument Digital Interface, is the standardized language for exchange of digital musical performance data for electronic musical instruments and computers.

3. Hypercard, familiar to Mac users, is a "hypermedia" program sold together with new Macintosh computers by Apple. The metaphor for the data structure is a stack of index cards, each card corresponding to a screen layout from which certain functions can be invoked. The screen display shown with this review, for instance, is one of the cards used in JI Calc.

and conversion to Yamaha's tuning units (1024 or 768 units per octave, depending on the synthesizer being used).

Although it is virtually impossible to garble the scale data if one follows directions, the <succ->rel> button does change the scale and it is not improbable that one may click it inadvertently.[4] JI Calc thoughtfully provides an undo button, <bot->top>, to take care of this eventuality.

JI Calc does not have a tuning index or sort function, but the Find and other functions under the GO menu may be used to locate a specific tuning once one has created an extensive library of scales. The use of easily remembered mnemonics like "31-TET" to name the scales is recommended for quick access, as flipping seriatim through the stack is very slow.

JI Calc is shareware and is available from Robert Rich at Soundscape Productions, PO Box 8891, Stanford, CA 94309 for $10. It is also available through the Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103. It requires a Macintosh computer or compatible with HyperCard version 1.2 or later; for synthesizer performance add a synthesizer of the DX7 II or TX81Z family (listed above), and one of the standard MIDI interfaces (Passport, Southworth, Opcode, etc.) Since this review of version 3.11 was written, the new upgrade JI Calc 3.2 has become available.

MICROTONAL MIDI TERMINAL

Reviewed by Bart Hopkin

Denny Genovese's MMT was designed primarily as a tuning modifier for Equal Tempered MIDI instruments. It works nicely as a quick and convenient calculator for microtonal tunings as well. One of its strengths in either case is its ease of use. The functions are straightforward in their operation, and the menus are easy to follow. There is no separate written documantation, but the on-screen documentation and context-sensitive help are complete and easily understood.

The first step in using MMT is the creation of a scale of your choosing, or, alternatively, reading in an already existing scale from a disk file. To create or modify a scale, MMT asks you to input ratios -- numerators and denominators representing the ratio of the frequency of each successive scale degree to a fundamental frequency. As part of the inputting process, each of your pitches will be assigned a different note name (C, C#, etc.) and, in effect, a piano key. The program then calculates the frequency of each new pitch thus designated and its distance from the tonic in cents (100ths of an equal tempered semitone). To aid in the scale building process, MMT can also help you add and subtract intervals in the form of ratios (e.g., 9/8 + 10/9 = 5/4), and automatically place them in an appropriate position (overrideable) in your scale.

MMT's frequency calculations are based upon a fundamental frequency which you can specify. Alternatively, you can accept a default value of A=440. There is a command that allows you to hear the chosen fundamental frequency through the computer's internal speaker. MMT is not set up to play the rest of the scale through the internal speaker -- you'll hear that only by hooking up a synthesizer. (Plans for the next upgrade of the program include the capacity to play entire scales over the internal speaker.)

When you have completed a scale over one octave, you can ask MMT to calculate the modes of the scale as well, automatically referencing all the intervals of the scale to the new starting point. MMT will print a page containing the new ratios of each of the twelve possible modes for the scale. This sheet will also contain the corresponding frequency, note name and cents value information for each interval.

A single keystroke will also generate your scale's pitch information in the form of Yamaha Tuning Unit Values. These values allow you to separately pre-tune certain microtuneable synthesizers -- namely, the Yamaha DX7II and TX81Z/DX11 families.

At present, MMT is not set up for input of scale information in forms other than ratios. If you wish to explore equal temperaments or other forms of scale generation, you must find the nearest rational equivalents to your desired intervals, and input those. On the other hand, you may find that the scale you seek is included in one of the tuning files included with the program, as are all the equal temperaments with less than twelve degrees.

Since the program is keyboard-oriented, it likes to work with twelve tones to the octave. Smaller numbers are no problem: you can focus on the essential tones of a less-than-12-note scale, leaving the default values for the remaining available notes and ignoring them. Larger numbers of tones per octave, however, are not available in this version of MMT. In the works for a future

EDIT MODE TUNING: 5 Limit FUNDAMENTAL: 264.000 TONIC: 0 = C

NOTE:	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
RATIO:	1/1	16/15	9/8	6/5	5/4	4/3	45/32	3/2	8/5	5/3	16/9	15/8
STEP:	0	1	2	3	4	5	6	7	8	9	10	11
SIZE:	0	1	2	3	4	5	6	7	8	9	10	11
BEND:	64	72	67	74	55	63	58	65	73	54	61	56
CENTS	0	112	204	316	386	498	590	702	814	884	996	1088
FREQ:	264	282	297	317	330	352	371	396	422	440	469	495

A=Add S=Subtract C=Change F=Fund T=Tonic M=Mode P=Performance

N=New R=Rename Z=Save G=Get Tuning Y=Yamaha H=Help Q=Quit

AT RIGHT: A screen from MMT, showing a basic 5 limit just.

4. This procedure has been changed in the more recent version of the program, JI Calc 3.2.

version is the capacity to handle full keyboard, non-octave-repeating tunings. This will allow you to crowd more tones into the sounding octave, while spreading that octave over a larger span of the keyboard.

With a synthesizer and hookups, you can hear the fruits of your labor; you can play music in the scales you've created. MMT's normal performance mode is fast and user-transparent enough for real time music making. Alternatively, there is a second performance mode designed to let you know what is happening on the MIDI lines, writing the information to the screen (in English), while it is happening. This mode is useful for getting familiar with the transformations that MMT performs on the MIDI data stream, and studying MIDI in general. But the screen writing slows things down slightly, making this mode unsuitable for normal performing situations.

You can change the tonic of the current scale or switch to an entirely new scale during performance without leaving the synthesizer keyboard, by means of MIDI signals which MMT can read. MMT holds 16 tunings in memory at one time.

For MMT to operate polyphonically, your synthesizer(s) must be capable of receiving on at least as many MIDI channels as the number of tones you will have sounding at one time. It doesn't matter what channel the keyboard sends the information to the computer on; MMT automatically handles the assignment of note information to successive MIDI channels. For those with single channel instruments, only monophonic performance is possible (though multiple single channel instruments set to different MIDI channels will function similarly to a multi-timbral synth). The reason a single channel can't handle polyphonic information is that different pitches in the scale require different degrees of retuning; yet MIDI pitch bend information, which MMT uses to do its retuning, affects all pitches on a given MIDI channel identically.

Microtonal MIDI Terminal is available from Denny's Sound and Light, PO Box 12231, Sarasota, FL 34287; phone: (813) 953-5833. System requirements are: IBM PC, XT, AT or compatible computer, DOS, and for performance: MPU-401 or compatible MIDI interface, MIDI synthesizer/MIDI controller. The cost is $50.

Denny Genovese is currently considering creating an acoustic instrument maker's software program, including calculators for string lengths, fret spacings, air column lengths and the like, as well as tuning reference tones from the computer's internal speaker. Anyone interested in knowing more, and anyone with thoughts on what should be included and how such a piece of software should be designed, is encouraged to contact Denny at the address or phone given above for Denny's Sound and Light.

INSTRUMENTS

COMPOSING "A COSMIC KOTO"

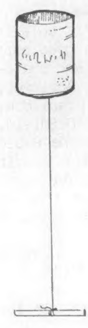
by Dudley Duncan

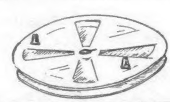
In this article I will describe a piece of music I composed and recorded twenty years ago using a single simple but effective source of sound and tape manipulation.

The initial sound source was an instrument consisting of a metal violin or guitar string drawn through a small hole in the bottom of a tin can and anchored there so that the can vibrated when the string was plucked. The other end of the string was attached to a weight and the weight was anchored to the floor with the foot. Thus the left hand was used to vary the tension of the string and control the position of the can while the right hand was free to operate the recording equipment. The plucking was done mechanically, in this manner: two pieces of plastic were glued to the face of a 7-inch tape reel in such a way that the angle separating them was slightly different from 180 degrees. When the reel turned freely and the string was brought into contact with the plastic pips, a strong, insistent sound was produced. It was recorded with a single mic very close to the can, sometimes actually within it. Three of these instruments were used at different times. Pitch was varied microtonally by holding the string under different degrees of tension. Timbre was altered by changing the angle at which the string entered the bottom of the can and also by varying the rate of plucking. Pitch variations in multiples of the octave were produced by playing back at different tape speeds (1 7/8, 3 3/4, or 7 1/2 ips) from the original recording.

The composition was assembled by selecting brief, contrasting episodes from a large amount of the recorded material and linking them into two distinct melodic lines which were then juxtaposed in the two stereo channels. Sound-on-sound was used to insinuate material from one channel into the other. Echo was used from time to time. Throughout the composition there are blips caused by splices. They were retained because they were congenial with the plucking impulse of the original material.

The composition was awarded Honorable Mention in the 1969 Electronic Music Contest of **High Fidelity** magazine, as reported in the July 1970 issue.





ELEMENTS OF THE COSMIC KOTO: A guitar string runs from a 1 lb. coffee can to a weight, anchored by the player's foot. The 7" tape reel has plastic pips glued to it, which pluck the string as the reel turns on the machine, when the string is held near.

Books

SCRATCH MY BACK:

A Pictorial History of the Musical Saw and How to Play It,

By Jim Leonard and Janet E. Graebner

Published in 1989 by Kaleidoscope Press, 1601 West MacArthur - 12F, Santa Ana, CA 92704. Price $19.95 + $3 S&H.

Reviewed by Bart Hopkin

Is musical saw playing a dying art? "Our research proves otherwise," say Janet Graebner and Jim Leonard in the preface to **Scratch My Back**. "You hold the proof in your hands."

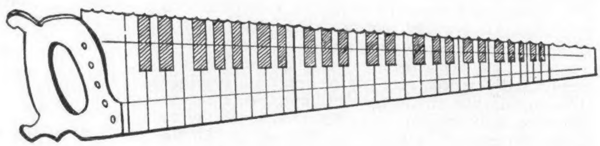
The proof, this book, is a gathering of something over a hundred pages of information on musical saws, sawing and sawyers. The book presents the culture of the musical saw in a fraternal and light-hearted mode; it is full of personalities, photographs of friendly-looking people, and sawing puns. Author Jim "Supersaw" Leonard is a long time, widely-acclaimed saw player (and gas appliance repairman); Janet Graebner is a business writer and communications consultant.

The time and place of the origin of musical saw playing are not known. The early chapters of this book present some of the possible lines of development, and tentatively suggest that the origins most likely lie in the middle of the last century, perhaps in Appalachia. More stories and documentation have come down to us from the period beginning around the turn of the century, and Leonard and Graebner follow this evidence through the saw's vaudeville and dance band glory days of the 20s and 30s. They also chronicle the founding and evolution of the most enduring musical saw manufacturing firm, Mussehl & Westphal, still operating today.

As we come to more recent years, we're able to meet the current crop of sawyers, and a good part of the book is devoted to their stories and photographs. Among those appearing: Tom Scribner, David Weiss, Morgan Cowin, Charlie Blacklock, Moses Josiah, Steve Porter, McKinley DeShield, Tatsuo Hamano, Margaret Steinbuch, Elfriede Hable and many, many more. (Just to spread the credit around further, some deserving sawyers not featured prominently in the book include Charles Noyes, Paul Lovens, Roy Brooks, Eddie Moore & Jerome Cooper).

Later chapters include discussions of playing technique and of the mechanics of the instrument itself, with its different makes and typical dimensions. Included are tips for physically modifying the saw for better playing, including drastically narrowing the small end to increase upward compass and general playability. The discussions of acoustics appearing here are a bit thin, in part because, as Leonard notes, no one has studied saw acoustics much. But there are photographs of nodal lines as evidenced by the dancing particles technique: baby powder sprinkled on a horizontally-held saw will dance its way to the areas of least vibration and form visible accumulations there when the saw is played. The most prominent nodes thus appearing are two lines running the length of the saw, about a fourth of the way in from each edge.

The book ends with some appendices, including a list of commercially made musical saws, plus bibliography, discography, and index. The 'ographies, not surprisingly, are short. After all, **Scratch My Back** is, as the front cover notes, "the ONLY book ever published about the carpenter's tool that became a musical instrument."



FURTHER RESOURCES FOR INFORMATION ON SAWING:

There are two newsletters devoted to sawing. Both are small and homey in style, typically four pages, appearing irregularly. They are **Musical Saw News**, PO Box 84935, San Diego, CA 92138-4935, and **Sawing News of the World**, put out by the Mussehl & Westphal company, at 1537 Beech Drive, East Troy, WI 53120.

Two companies currently make musical saws as such: Mussehl & Westphal, at the Wisconsin address above, and the Sandvik firm in Sanviken, Sweden, which produces a very small quantity of musical saws alongside their large line of woodcutting saws. In addition, many sawyers play regular carpenters' saws. The debate as to whether carpenter's saws can serve as well as those manufactured specifically as musical saws continues unresolved, but it does appear that made-for-music saws are generally of consistent musical quality, while carpenter's saws tend to vary drastically from one to the next, even among saws of the same product line.

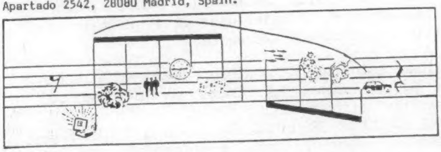
NOTICES

POLYRHYTHMIC NEW FOLK MUSIC: Rising Tide, a new cassette tape from White Bear Enterprises, is now available. Bob Grawi on Gravikord (featured in EMI Volume III #6), with Pip Klein on flute, David Dachinger on Bassoon, and Geoffrey Gordon on Tabla. $11 from White Bear Enterprises, 247 West 16th St., New York, NY 10011. Other tapes are available too, including Gravikord demonstration tape and additional information on the Gravikord.

RATIONAL MUSIC FOR AN IRRATIONAL WORLD is the new compilation cassette tape from the Just Intonation Network, featuring 18 compositions in Just Intonation by members and friends of the network. $9.98 ($8.98 for network members) from The Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103.

I DO AN EXPERIMENTAL RADIO PROGRAM on local independent radio station 3RRR FM. If anyone wishes to send tapes of unusual instruments or experimental music along with relevant information, I will try to air them. Howard Marklin, 4 Merimbula Rd., Ferny Creek, 3786 Victoria, Australia.

SAMPLER HOME USERS ASSOCIATION is an organization devoted to study and enjoyment of the possiblities and/or uses of the sampler as a technical instrument for creation, through the establishment of an international network for exchanging recordings. For more information contact Francisco Lopez, Apartado 2542, 28080 Madrid, Spain.



THE ONLY BOOK IN SAWING: **Scratch My Back: A Pictorial History of the Musical Saw and How to Play It**, by Jim Leonard and Janet Graebner. Features profiles of sawyers world-wide in 124 pages of fascinating information. Includes over 100 photos and illustrations, index and bibliography. U.S. Dollars $19.95, $3 shipping/handling (in CA add 6% tax). For information, contact Janet E. Graebner, Kaleidoscope Press, 1601 West MacArthur, #12F, Santa Ana, CA 92704.

MARIMBA BAR TUNING through the third harmonic; marimbas custom built and rebuilt; Helmholtz resonators made to order. MARIMBA ONE, PO Box 786, Arcata, CA 95521, phone (707) 839-5725.

MICROTONAL MIDI TERMINAL by Denny Genovese is a real time performance program for just intonation on virtually any MIDI controllable musical instrument; also a powerful tool for analyzing & constructing microtonal scales. System requirements: IBM PC, XT, AT or compatible with 128K, DOS, Roland MPU- 401 or compatible MIDI interface, MIDI controller and MIDI controllable musical instrument. $50. Denny's Sound & Light, PO Box 12231, Sarasota, FL 34278.

JUST INTONATION CALCULATOR by Robert Rich. Composer's tool for JI. Internal sound for tuning reference; shows modulations; reduces fractions; converts between ratios, cents, DX7II/TX81Z units; MIDI tuning dumps. Requires Macintosh with Hypercard -- only $10.00. Soundscape Productions, Box 8891, Stanford, CA 94309.

EMI BACK ISSUES: Back issues of **Experimental Musical Instruments** numbered Volume V #1 and later are individually available for $3.50 apiece. Earlier issues available in volume sets of 6 issues each, photocopied and bound: Volumes I through IV, $14 per volume. Order from EMI, PO Box 784, Nicasio, CA 94946, or write for complete listing. Corresponding cassette tapes also available for each volume; see information below.

CASSETTE TAPES FROM EMI: **From the Pages of Experimental Musical Instruments**, Volumes I through IV, are available from EMI at $6 per volume for subscribers; $8.50 for non-subscribers (each volume is one cassette). Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Order from EMI, Box 784, Nicasio, CA 94946.

(RECENT ARTICLES, continued from page 24)

CHOICE OF MEANS FOR MUSIC, by Jocelyn Robert, discusses the role of the chosen instruments or sound sources in determining the nature of musical compositions, with special reference to the phonograph turntable manipulations of Christian Marclay and small electro-acoustic devices used by Pierre-Andre Arcand.

A SHORT HISTORY OF LIVE ELECTRONIC MUSIC by Roger Sutherland is a review of diverse approaches to electronic music performance since 1960, with dissenting views inserted (by agreement with the author) by editor Chris Cutler.

And in Vol. 3 #1:

BUILDING ELECTROACOUSTIC MUSICAL INSTRUMENTS by Robert Matthews discusses the options in transducers including a number of unconventional possibilities (tape heads, opto-electrical transducers, industrial air pressure transducers), then focuses on a particular application of electroacoustic methods: feedback instruments, including strings, winds and membranophones which make use of a controlled feedback cycle.

Among the pieces on this issue's LP is "Bakerloo Boogaloo" by a group called Overflow. According to notes appearing in the magazine, they use lots of plastic pipe, both as percussion aerophones and blown aerophones, as well as various sorts of marimbas and other percussion. The music is great.

Another piece on the LP is "Bells," created by Don Wherry in connection with the Sound Symposium festival in Newfoundland. In it were church bells, ships horns and alphorn, spread out across the city and harbor of St. John's.

RECENT ARTICLES IN OTHER PERIODICALS

The following is a selected list of articles of potential interest to EMI readers which have appeared recently in other publications.

DAY OF THE [BLACK] LOCUST by John M. Larsen, in **String Instrument Craftsman** Vol. 3 #11, Jan/Feb 1990 (142 N. Milpitas Blvd., Suite 280, Milpitas, CA 95035 [this is a new address]).

In light of the increasing scarcity of tropical tonewoods and the questionable ethics of continuing to harvest them, the author suggests black locust, a common domestic hardwood, as an alternative for luthiers.

LASER TECHNOLOGY IMPROVES D'ADDARIO STRINGS, no author credited, in **The Music Trades** Volume 138 #1, Feb. 1990 (PO Box 432, Englewood, NJ 07631).

This article describes the use lasers and computers, recently introduced at the D'Addario musical string factory, to check nylon strings for dimensional inconsistencies within precise specifications.

DESIGNING INSTRUMENTS AND THE SOUNDS THEREIN by Allan Kozinn, in **The New York Times**, Jan. 28, 1990.

Review of a Guggenheim Museum concert of works by composer Tan Dun. Tan worked with ceramicist Ragnar Naess to create more than fifty new instruments, including struck bowls and gongs, and even ceramic string instruments.

CALIFORNIA LIBRARY OF NATURAL SOUNDS by Paul Matzner, in **Nature Sounds Society Newsletter** Winter 1990 (Oakland Museum, 1000 Oak St., Oakland, CA 94607).

A review of the resources available through the Oakland Museum's recorded natural sound library.

CLAIR OMAR MUSSER AND HIS CONTRIBUTIONS TO THE MARIMBA by David P. Eyler, in **Percussive Notes** Vol. 28 #2, Winter 1990 (Box 697, Urbana, IL 61801-0697).

A survey of the contributions of one of the pioneers and innovators in vibrating bar instruments in the United States.

Also in this issue of **Percussive Notes** (address above): Several articles on cymbals, including a biographical piece on cymbal manufacturer Avedis Zildjian, and informative photographs of cymbal manufacturing processes accompanying Rich Holly's introduction to the issue's feature on cymbals.

BASSES, BOATS AND MOTORCARS: ON BUILDING A BASS FROM A BASSIST'S POINT OF VIEW by David Wiebe, in **Strings** Jan/Feb 1990 (PO Box 767, San Anselmo, CA 94960).

The designing and building of a string bass (far less standardized in design than the higher strings), recounted by player turned builder.

FOUR GOURD RESONATED MUSICAL INSTRUMENTS by Tony Pizzo, and GOURD MUSICAL INSTRUMENTS FOR BEGINNERS by Bart Hopkin, in **The Gourd** Vol. 20 #1, Winter, 1990 (Mount Gilead, OH 43338).

Two short articles on making gourd string instruments using gourds. The Pizzo article is a reprint from and earlier piece in EMI.

HARPMAKER'S NOTEBOOK #12 -- REAL STRINGS, PART 3 by Mark Emery Bolles, in **Folk Harp Journal** #67, Winter 1989 (4718 Maychelle Dr., Anaheim, CA 92807-3040).

The third installment in this excellent series on strings discusses string scaling.

BUILD YOUR DREAM by Mario G. Daigle, also in **Folk Harp Journal** #67 (address above).

An amateur maker describes the proccss of designing his own folk harp with advice from several professional builders.

Balungan Vol. 4 #1, May 1989 (American Gamelan Institute, Box 9911, Oakland, CA 94613) features several articles on Gamelan in Great Britain, as well as Indonesia and elsewhere.

American Lutherie #20, Winter 1989 (8222 South Park Ave., Tacoma, WA 98408) contains several noteworthy articles, among them:

THE MANDOLIN ORCHESTRA IN AMERICA, PART 2, by Joseph R. Johnson, contains information on and photos of several beautiful and exotic mandolins.

AN INTERVIEW WITH STEWART POLLENS, conducted by Cyndy Burton, focuses on instrument conservation and restoration in museums.

STRING MAKING: OLD AND NEW, by James Rickard, transcribed from a Guild of American Luthiers Convention lecture, is a rare inside look at technical aspects of musical string manufacture at the D'Addario company.

HISTORICAL LUTE CONSTRUCTION, by Robert Lundberg, continues a series on lute making.

Journal of the American Musical Instruments Society Volume XV, 1989 (414 E. Clark St., Vermillion, SD 57069-2390) has appeared. Among the articles:

INDIAN FLUTES OF THE SOUTHWEST, by Richard W. Payne, discusses several pre-Columbian flutes.

THEOPHILUS ON MAKING ORGAN PIPES, by Wilson Barry, looks at one of the earliest extant works on organ pipes, from around the year 1100.

In addition there are several articles on historical European instruments and their makers.

Several noteworthy articles appear in **ReR Records Quarterly Magazine** Volume 2 #3, 1988, and Volume 3 #1, undated (19-23 Saint Saviour's Rd., London SW2 5HP, UK). Issues of the quarterly include a magazine and an LP record in a single parcel.

In Vol. 2 #3:

A 'PERSONAL SYSTEM' FOR ELECTRONIC MUSIC, by David Meyers, discusses the use of mass-produced digital hardware to produce a highly individual (i.e., un-mass-produced) instrument. This article will be reprinted in a coming issue of in EMI.

(more on page 23)